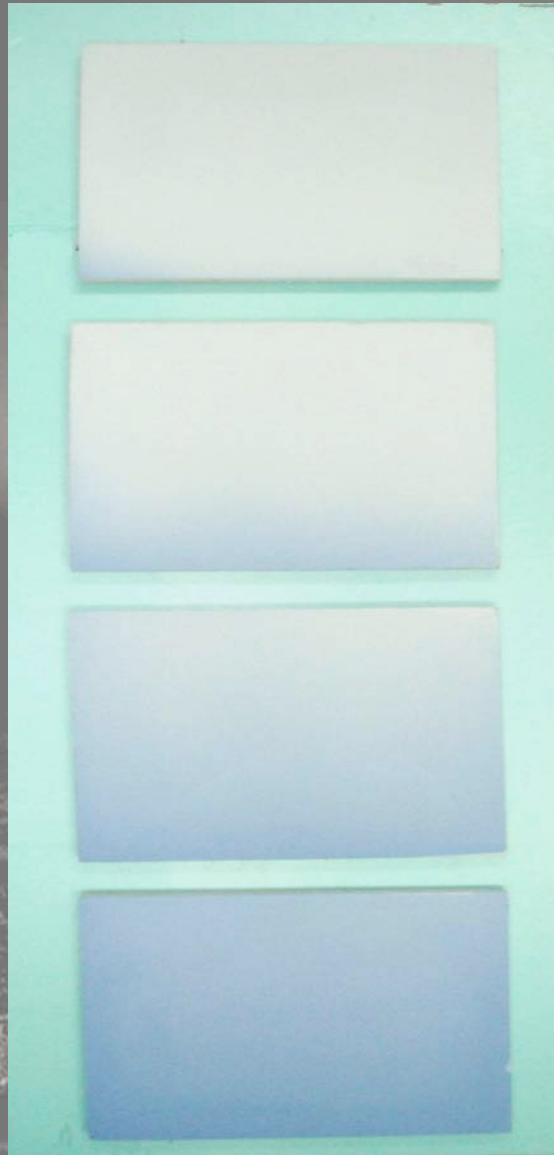


Thermochromic energy efficient coatings for buildings and urban structures

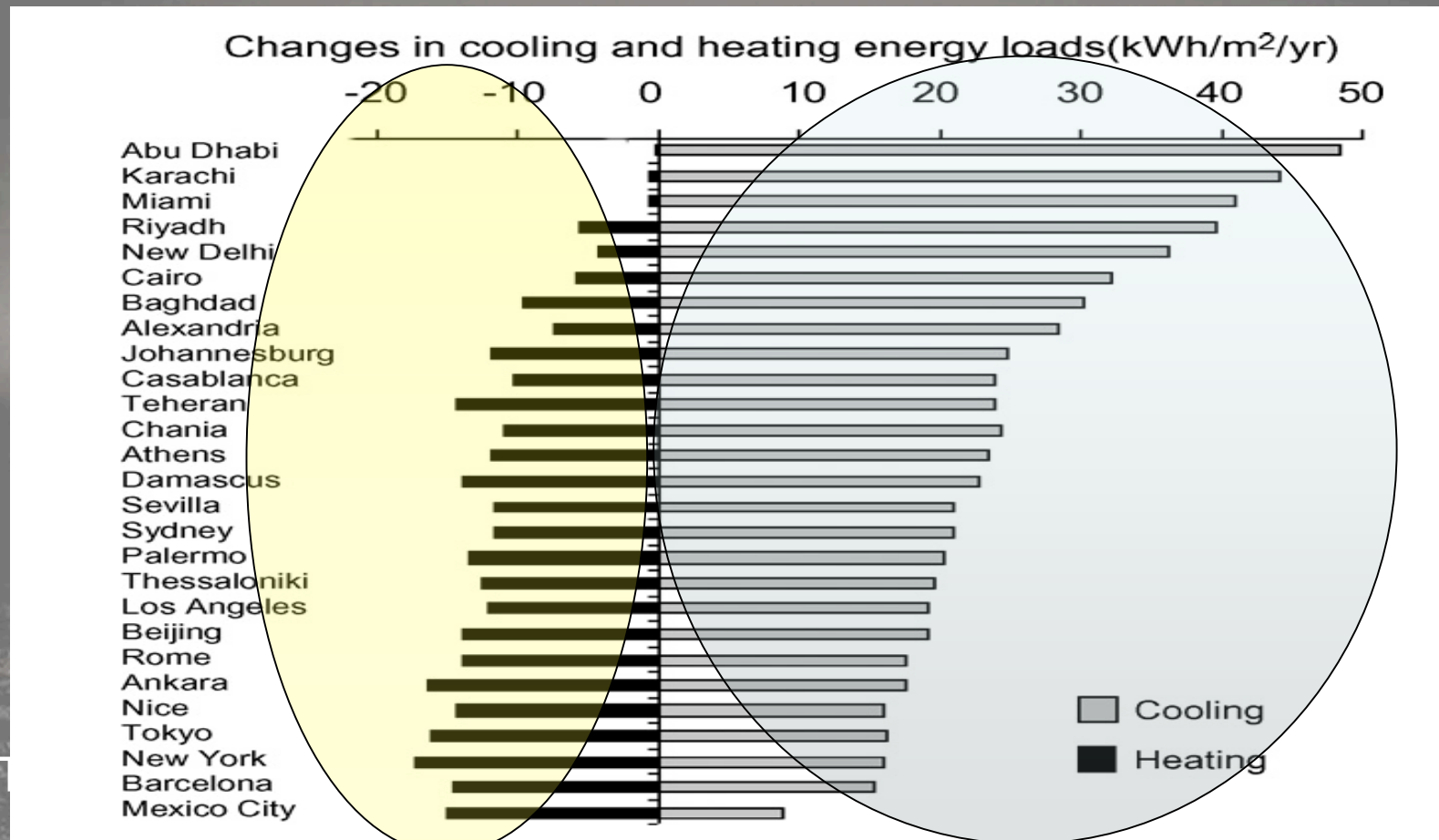
T. Karlessi, A. Synnefa, M. Santamouris,

National and Kapodistrian University of Athens

Second International Conference on
Countermeasures to Urban Heat Islands
Berkeley, USA, 21-23d September 2009



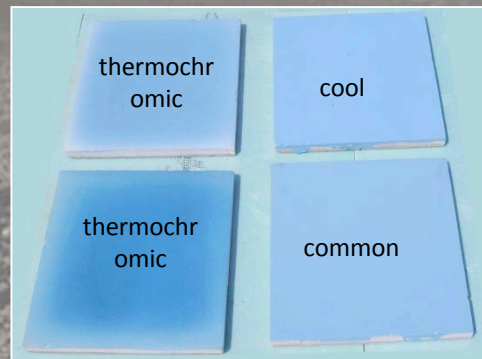
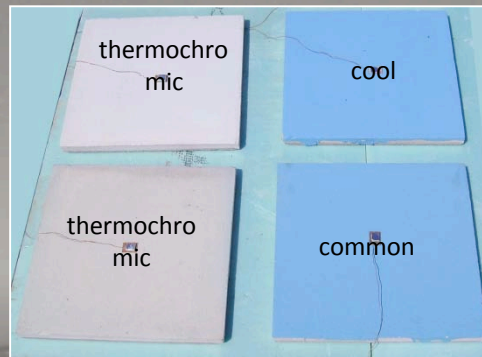
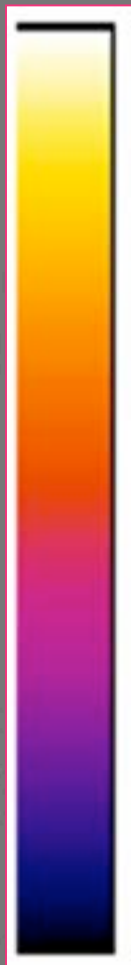
ENERGY IMPACT OF REFLECTIVE COATINGS



A. Synnefa, M. Santamouris and H.Akbari: Estimating the effect of using cool coatings on energy loads and thermal comfort in residential buildings in various climatic conditions, Energy and Buildings, 39,11, 1167-

1174, 2007

DEVELOPEMENT OF THERMOCHROMIC COATINGS

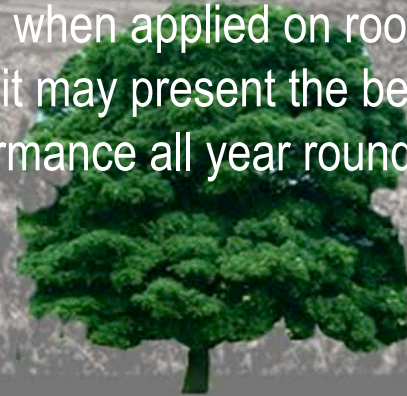


Thermochromic coatings change color as a function of the ambient temperature.

For low outdoor temperatures, winter, the coatings may be dark presenting a high absorptivity.

For higher ambient temperatures, summer, the coating becomes white presenting a high reflectivity.

Thus, when applied on roofs or walls it may present the best performance all year round.

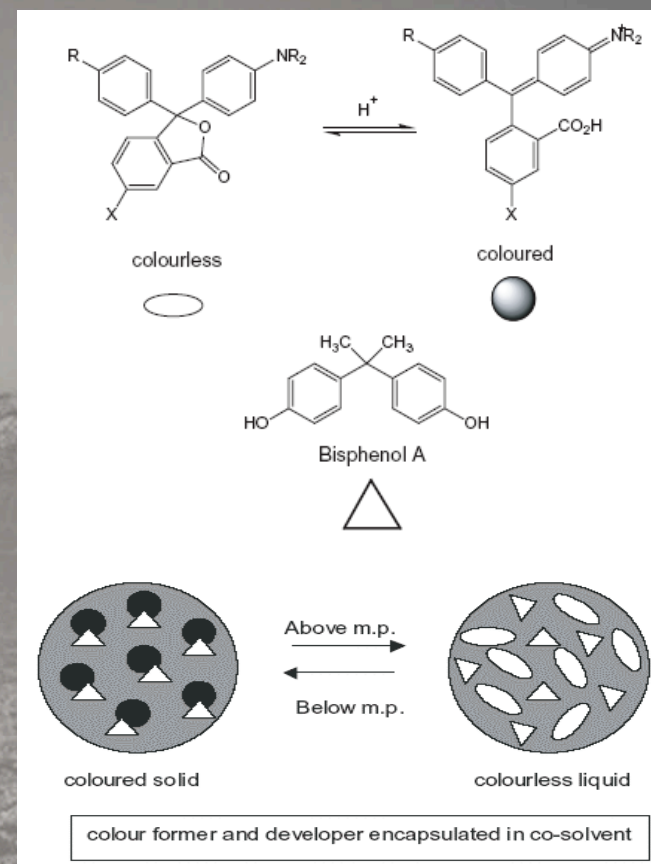


DEVELOPEMENT OF THERMOCHROMIC COATINGS




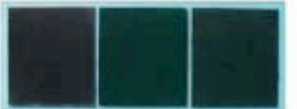


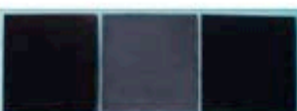
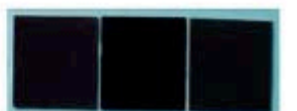


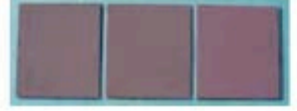
Thermochromism is the reversible colour change of a substance induced by temperature change.

Composition of organic thermochromic dyes

- the color former:
usually a cyclic ester which determines the color of the final product in its colored state
- the color developer:
usually a weak acid that imparts the reversible color change to the thermochromic material and is responsible for the color intensity of the final product
- the solvent:
usually an alcohol or an ester, whose melting point controls the temperature at which the color change occurs



DEVELOPEMENT OF THERMOCHROMIC COATINGS

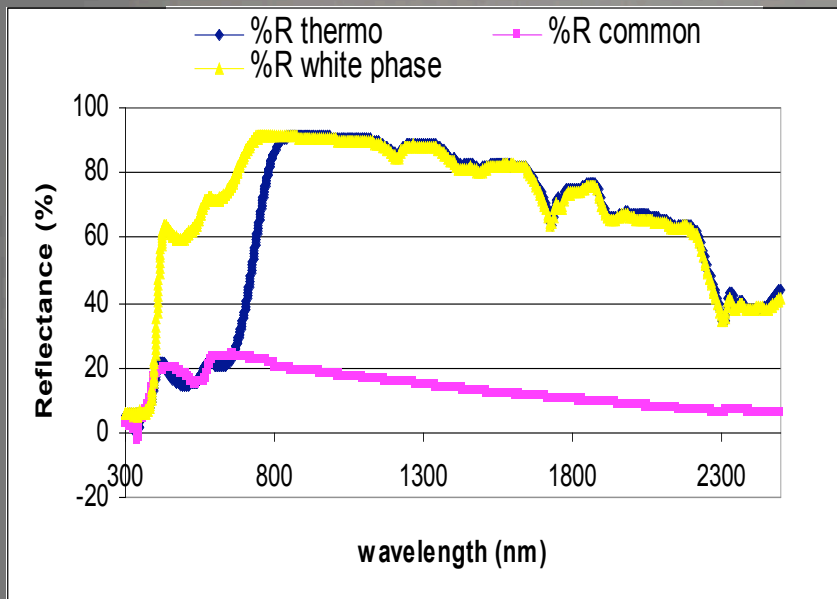
THERMOCHROMIC COATINGS		
with TiO_2	color	without TiO_2
thermochromic cool common		thermochromic cool common
	YELLOW	
	GREEN	
	GREY	
	BLACK	
	BLUE	
	BROWN	

Several thermochromic coatings have been developed using different types of thermochromic basic materials

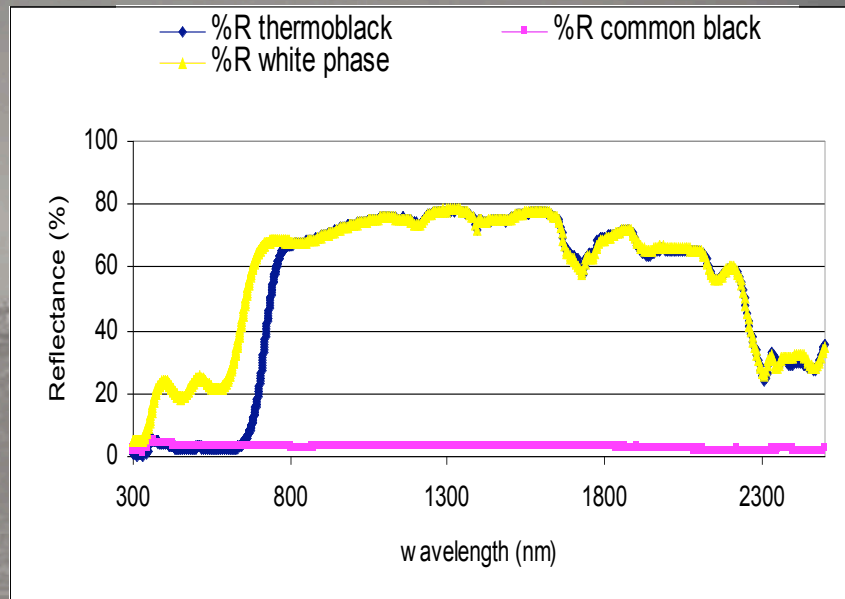


DEVELOPEMENT OF THERMOCHROMIC COATINGS

Brown



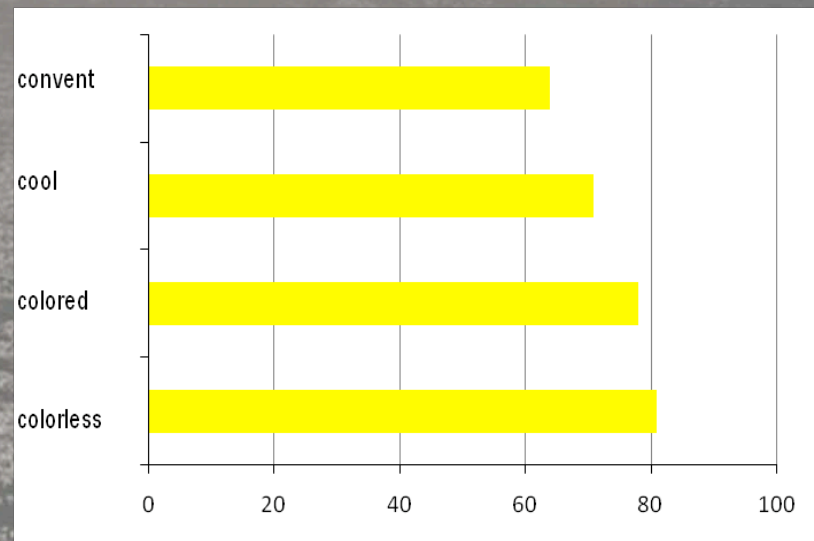
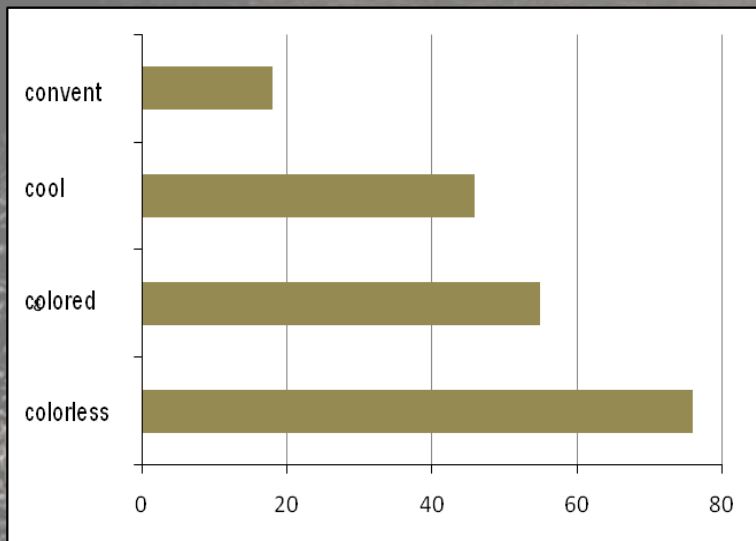
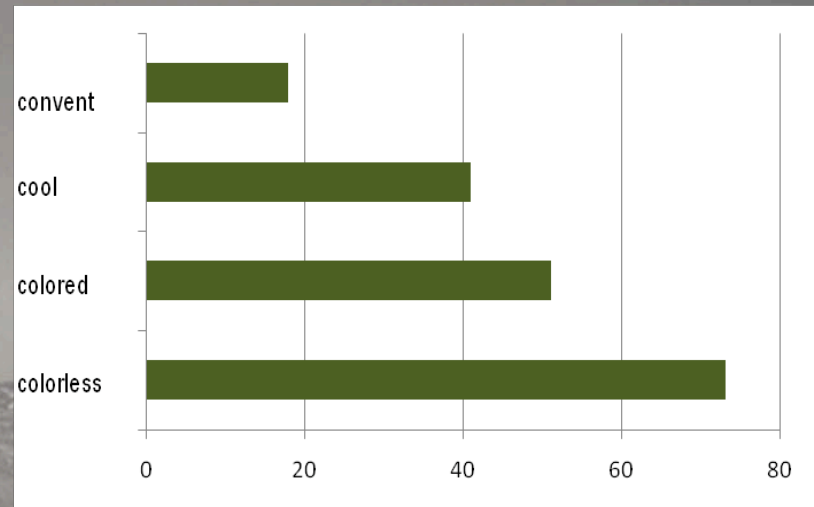
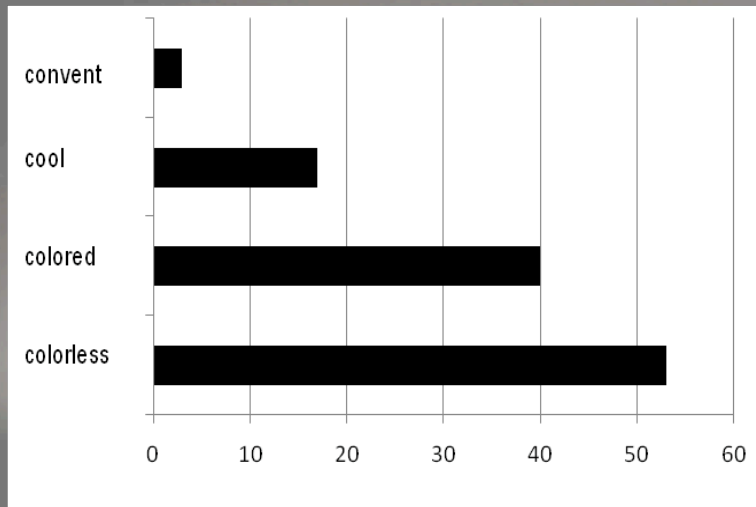
Black



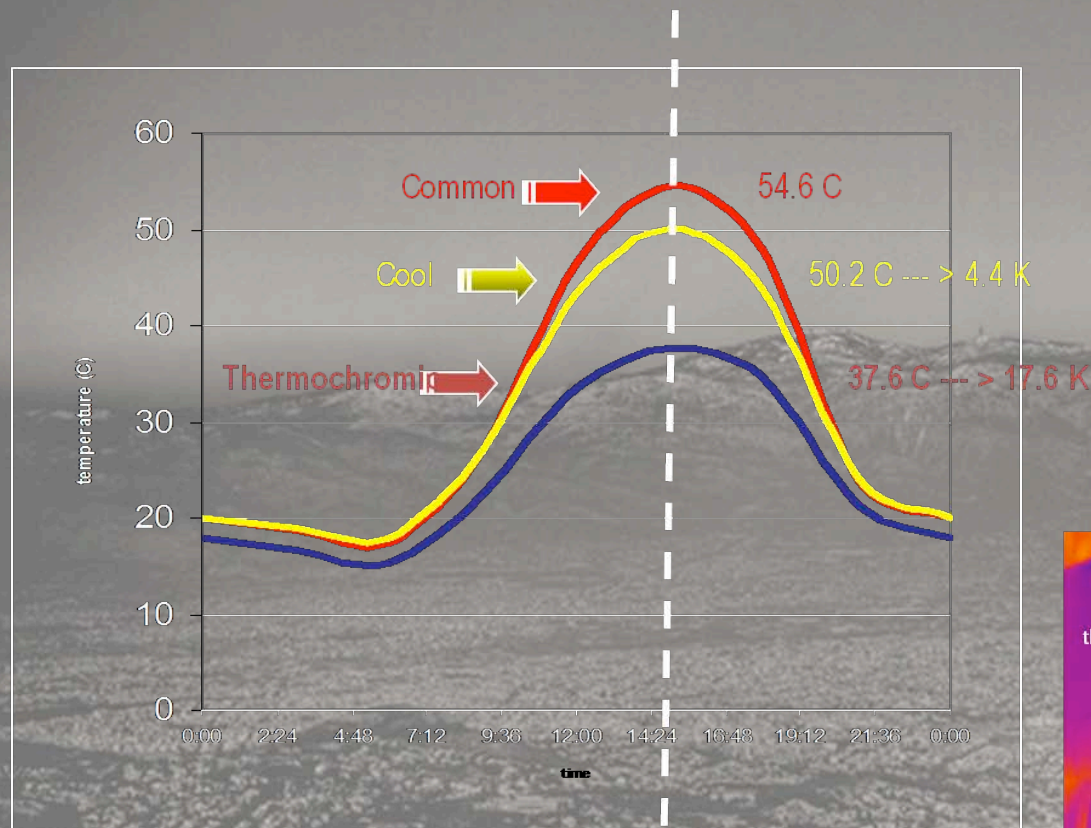
Thermochromic coatings present a high reflectivity both in the visible and infrared spectrum, while present very strong absorption in the near-ultraviolet range of the spectrum.

T. Karlessi, M. Santamouris, K. Apostolakis, A. Synnefa, I. Livada : Development and Testing of Thermochromic coatings for Buildings and Urban Structures, Solar Energy, 2008

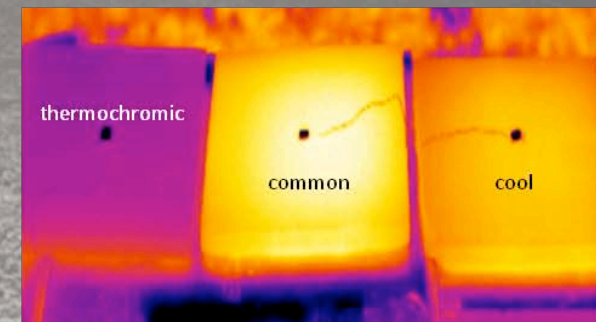
DEVELOPEMENT OF THERMOCHROMIC COATINGS



DEVELOPEMENT OF THERMOCHROMIC COATINGS

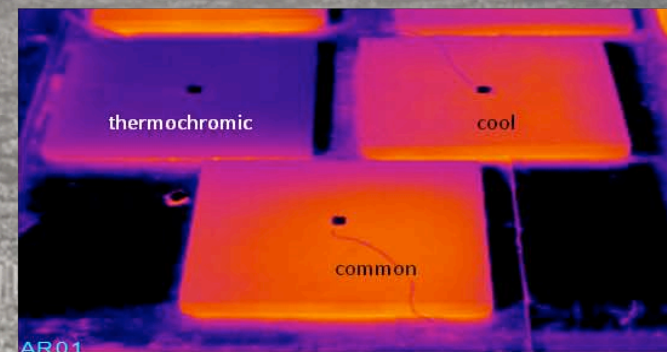
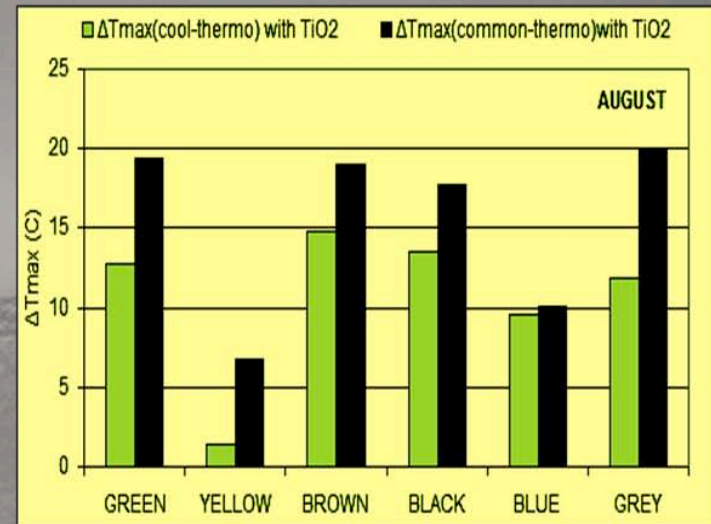
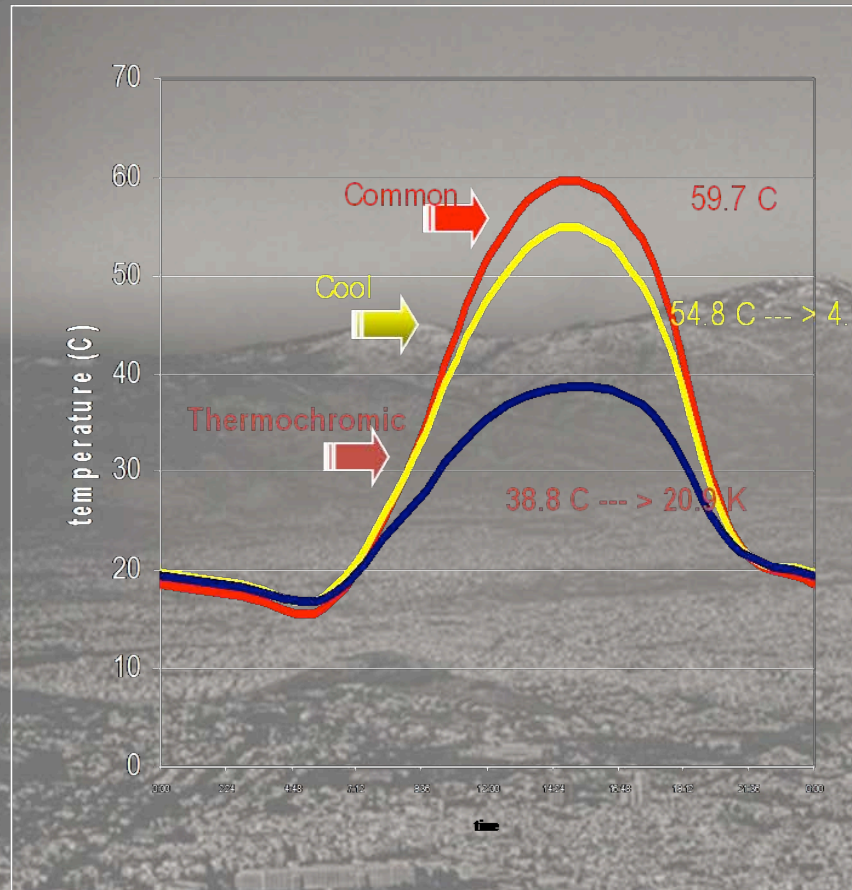


Brown



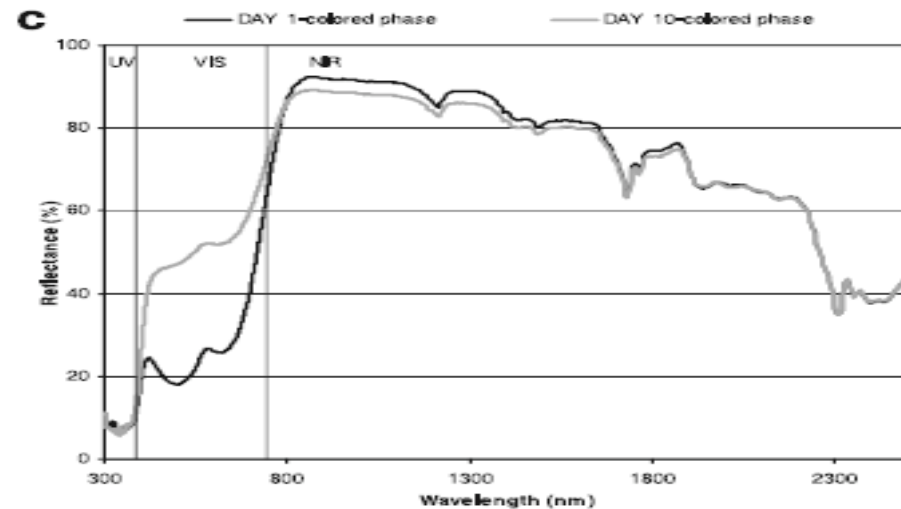
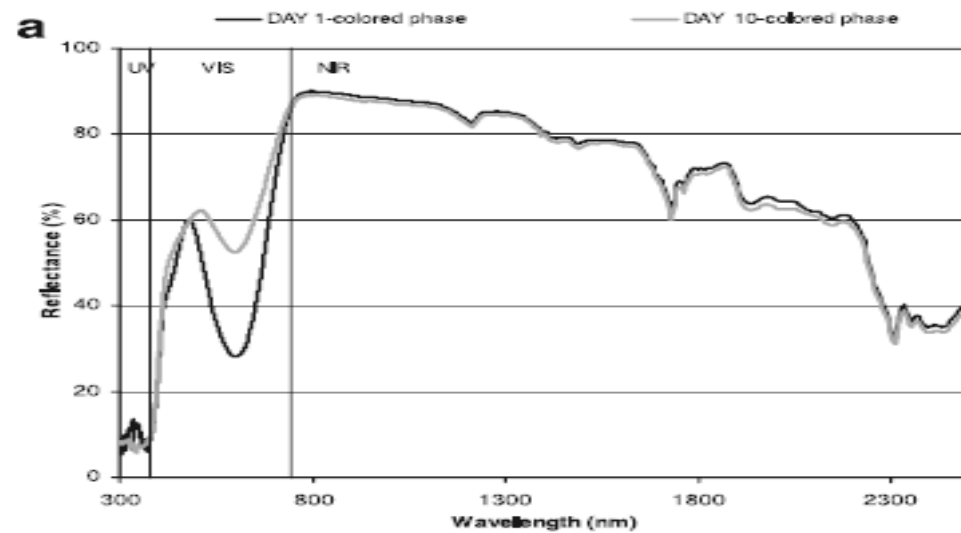
T. Karlessi, M. Santamouris, K. Apostolakis, A. Synnefa, I. Livada : Development and Testing of Thermo-chromic coatings for Buildings and Urban Structures, Solar Energy, 2008

DEVELOPEMENT OF THERMOCHROMIC COATINGS



T. Karlessi, M. Santamouris, K. Apostolakis, A. Synnefa, I. Livada : Development and Testing of Thermo-chromic coatings for Buildings and Urban Structures, Solar Energy, 2008

DEVELOPEMENT OF THERMOCHROMIC COATINGS



Important problem of ageing



DEVELOPEMENT OF THERMOCHROMIC COATINGS

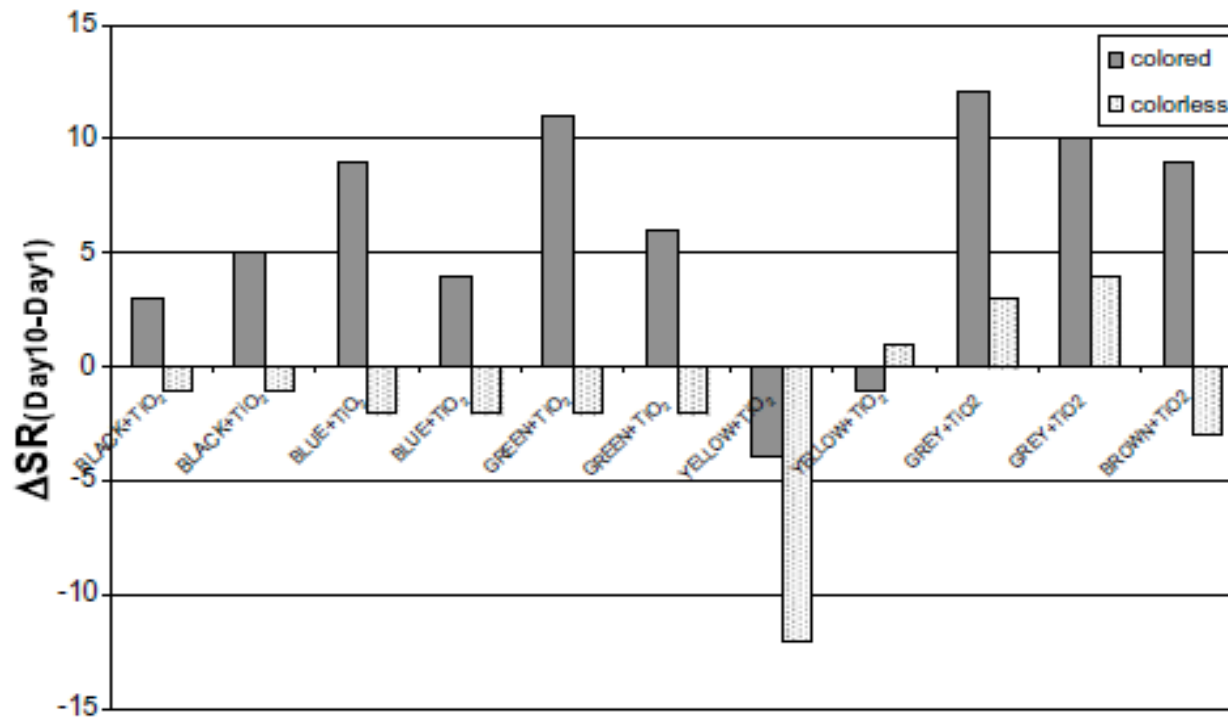
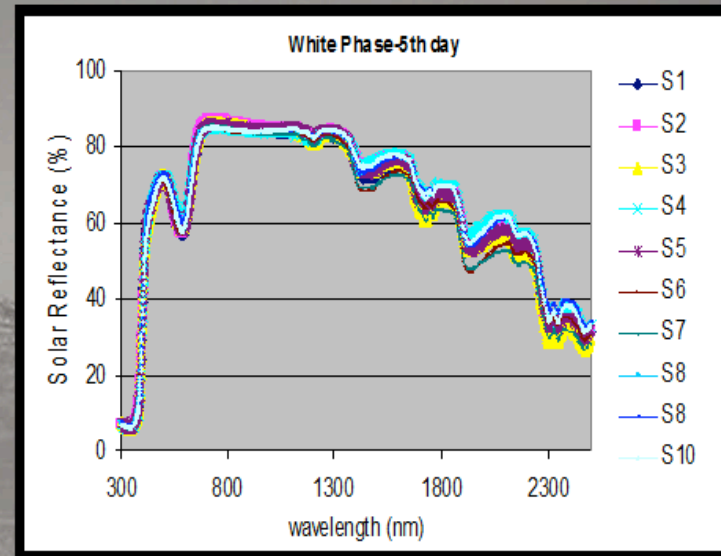
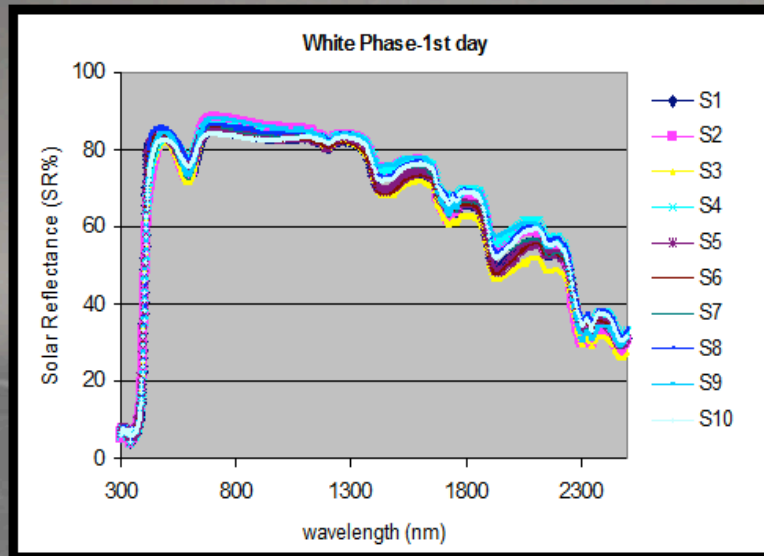


Fig. 11. Solar reflectance difference (ΔSR) between 1st and 10th day for thermochromic coatings.

Important problem of ageing. After almost one week, loose their initial optical characteristics. In particular, loose their ability to change color and their reflectivity is stabilised.



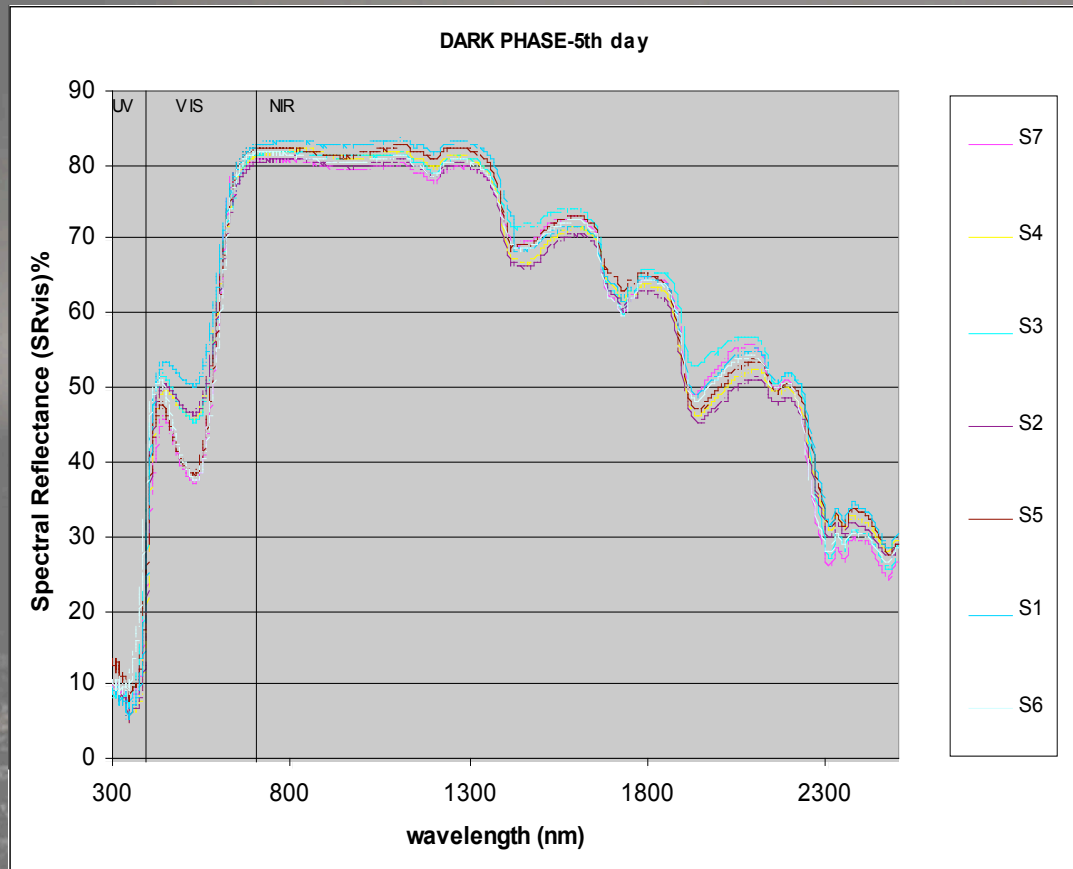
DEVELOPEMENT OF THERMOCHROMIC COATINGS



Important problem of ageing. When UV Absorbers are added in the thermochromic paints, the optical efficiency is not improving and the ageing problems remain



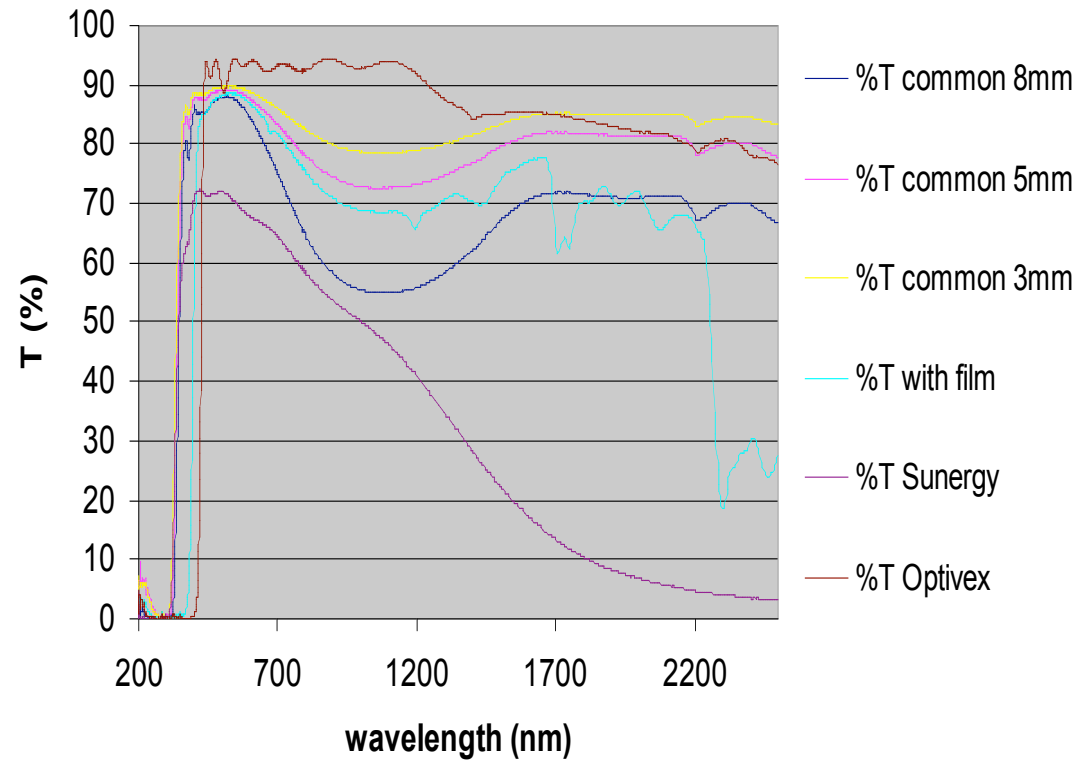
DEVELOPEMENT OF THERMOCHROMIC COATINGS



When UV protectors are placed on the surface of the coatings, (cascade techniques), the optical efficiency is improved but still the problem of ageing is important



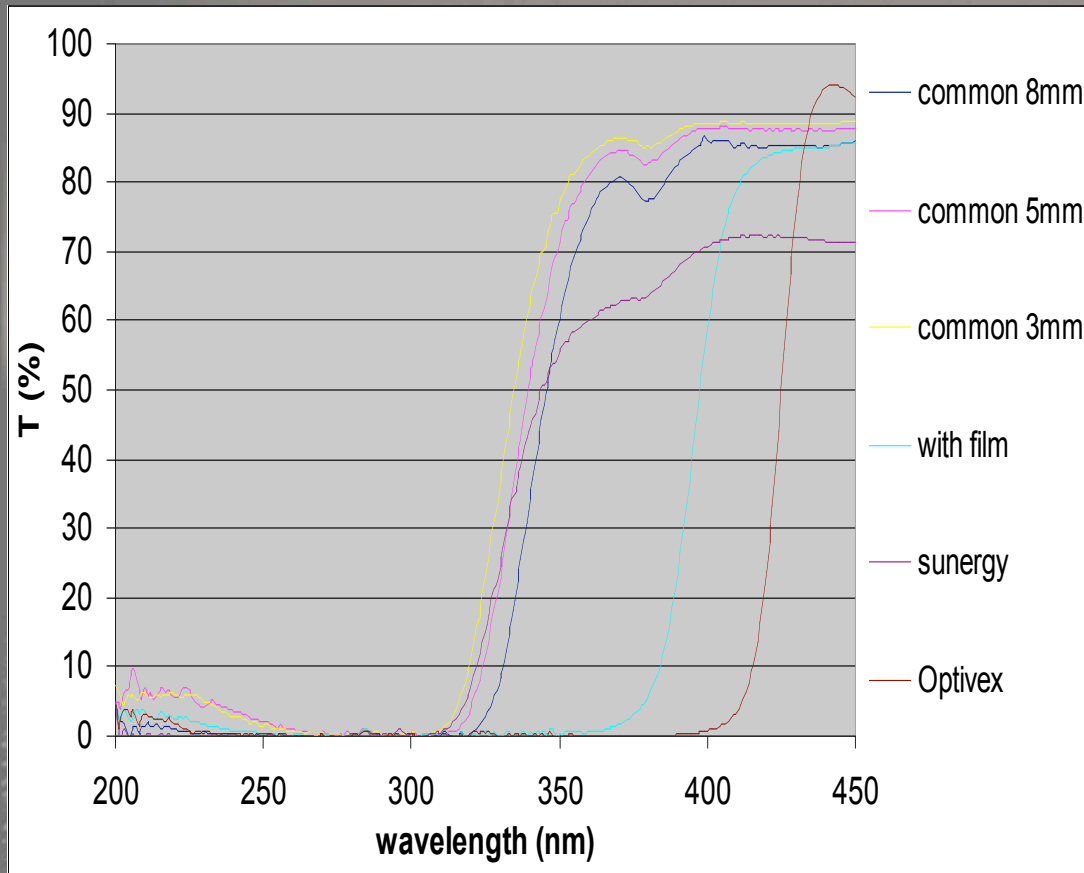
DEVELOPEMENT OF THERMOCHROMIC COATINGS



Use of full UV filters. Full UV filters present a UV transmissivity close to zero



DEVELOPEMENT OF THERMOCHROMIC COATINGS



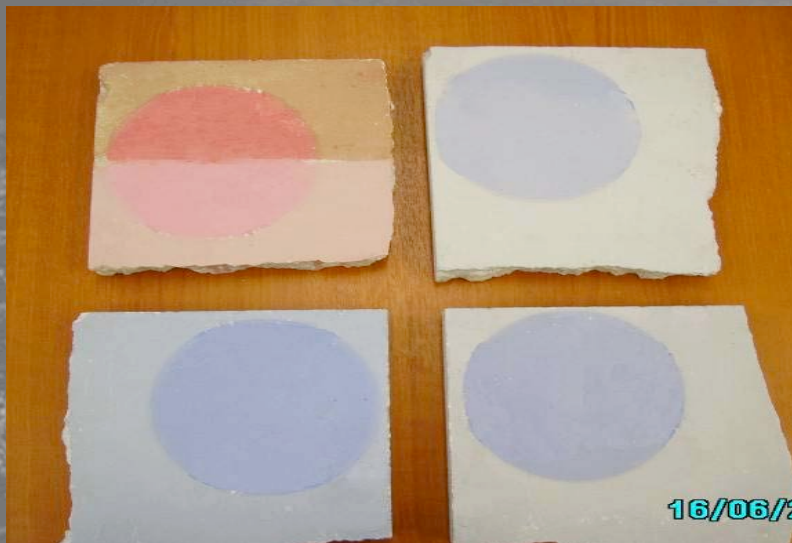
Use of full UV filters. Full UV filters present a UV transmissivity close to zero



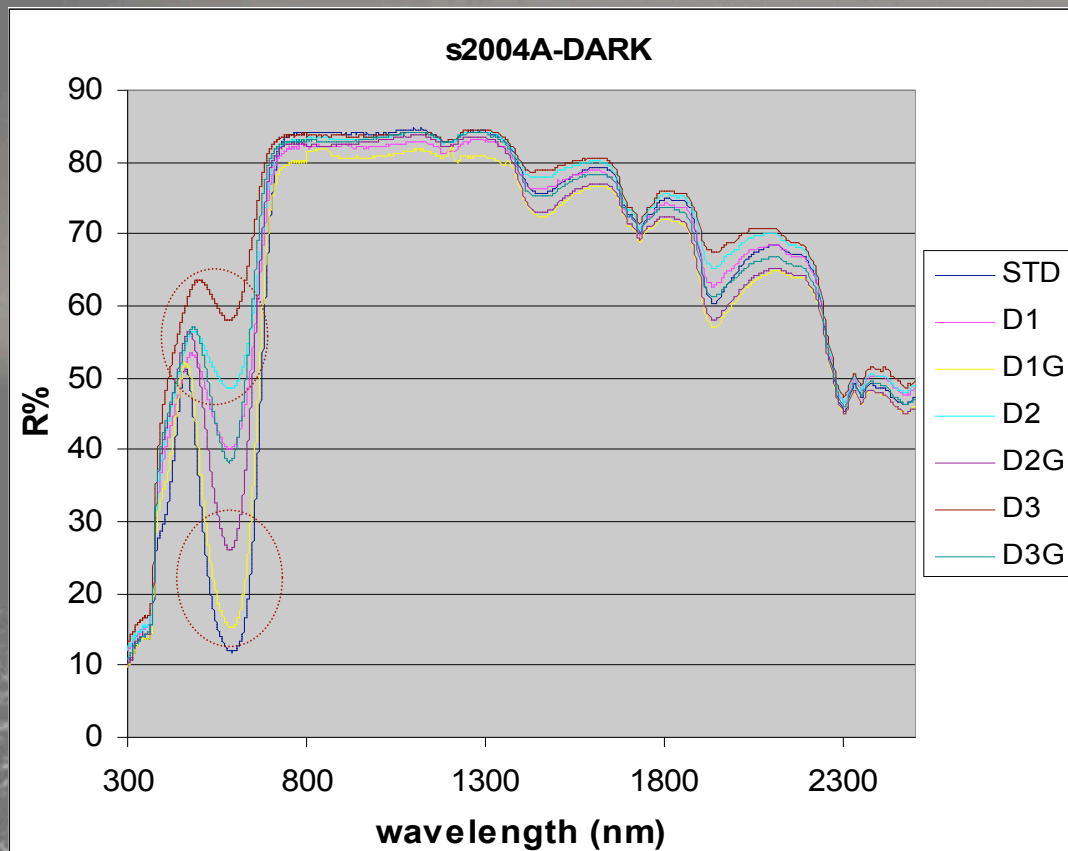
DEVELOPEMENT OF THERMOCHROMIC COATINGS



The Optical performance improves considerably.



DEVELOPEMENT OF THERMOCHROMIC COATINGS

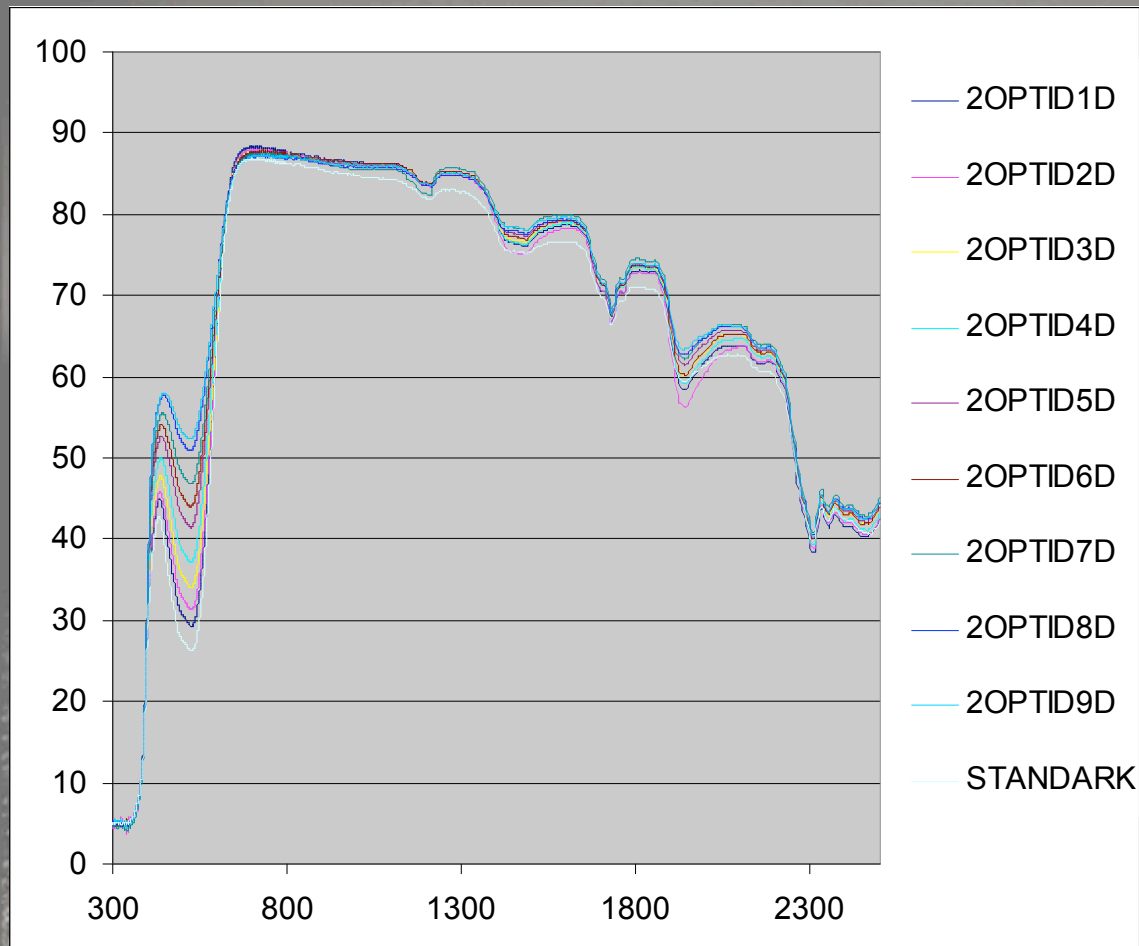


Use of full UV filters.
Full UV filters present a UV transmissivity close to zero.

Although the optical performance improves considerably, the problem remains.



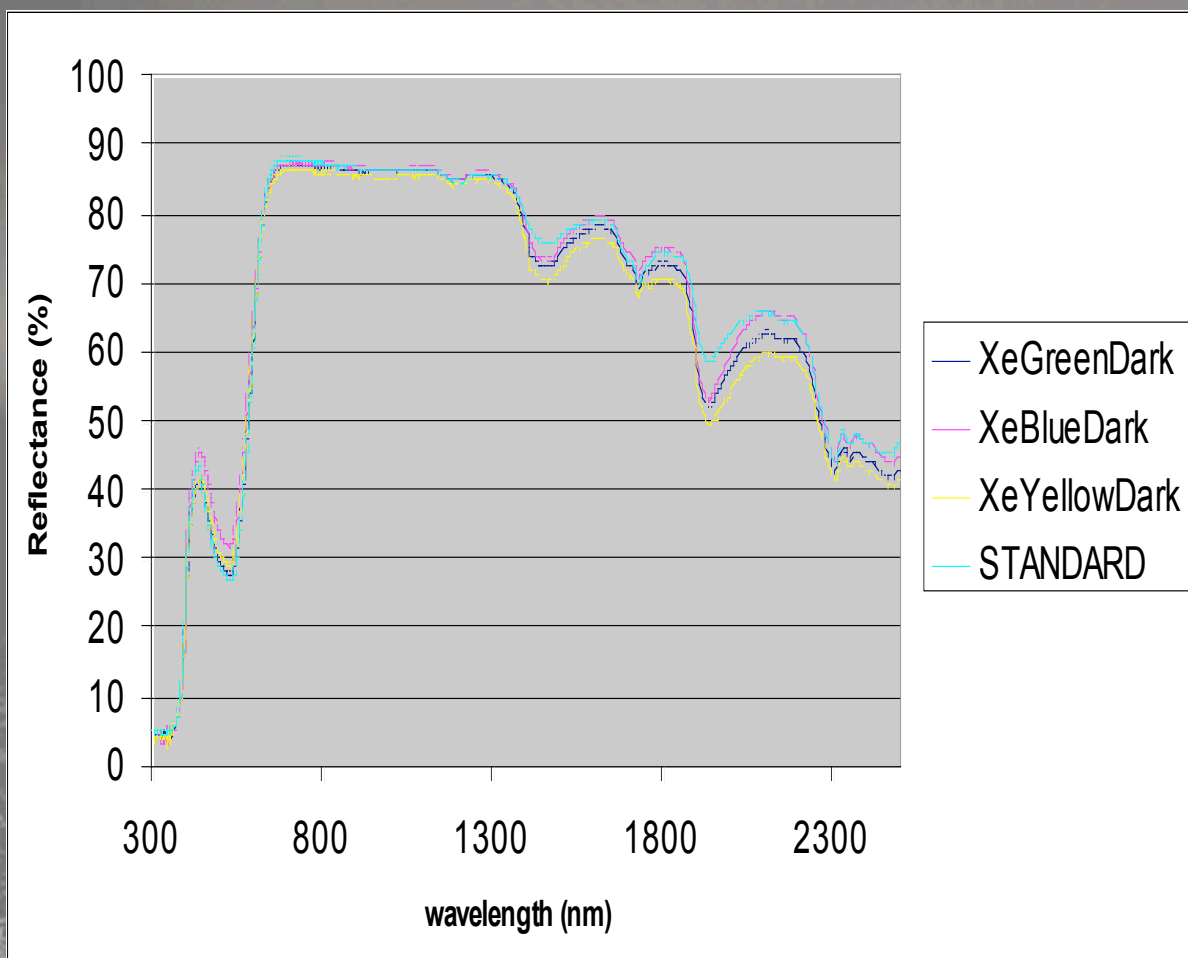
DEVELOPEMENT OF THERMOCHROMIC COATINGS



Even with 2 full layers of UV protecting films the problem of ageing is important.



DEVELOPEMENT OF THERMOCHROMIC COATINGS



UV and visible optical filtering techniques have been used using different coating techniques. The results after one month of accelerating ageing are very promising



DEVELOPEMENT OF THERMOCHROMIC COATINGS

Thermochromic Coatings present important advantages. Can increase reflectivity during the warm period while present high absorptivity during winter.

Thermochromic coatings have been prepared and tested in the outdoor environment. Their thermal performance found to be excellent.

However, thermochromic coatings present a very serious problem of optical ageing.

The results of various unsuccessful scientific efforts to improve their optical performance have been presented.

Use of optical filtering techniques have been employed and the results are very promising.

